SCIENCE AND SOCIETY

High- and Low-Cost Realities for Science and Society

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Through the ongoing proliferation of images and symbols, information overload and hi-tech–driven media, science increasingly communicates with the public in ways that are deliberately designed and intended to meet the public (and political) imagination. At the same time, the public is led to imagine what the sciences and scientists mean and say. The appeal to the imagination can be pursued through different avenues. One is that of fiction, a recent example of which is Michael Crichton's blockbuster *The State of Fear* (*1*). In his plot, scientists are colluding with the environmental movement, making up facts when necessary, in order to support a common cause. In a shrewd move of having environmental lawyers rehearse possible arguments that the defense might use against them, he lectures extensively in the guise of the scientific graphs and footnotes and by presenting whatever else looks like scientific evidence, about all that is wrong with global warming. It is a mix of science, advocacy, and a vision of scientists whose idealism leads them astray. It has been on 37 best-seller lists with another book that looks at the impact of environmental change in a very different way: Jared Diamond's *Collapse* (*2*), which is based on a scholarly analysis of a series of case studies of ancient civilizations. If Crichton's book is taken not as a work of fiction, but becomes equated with one of fact, like Diamond's, do we not run the risk that trust in science will be decided by market forces and continuing sales figures? The public has become accustomed in a media-saturated world to switching between fact and fiction—but how far does this extend? The question I want to pose is whether in the desire to communicate with "society," "science" has contributed to a confusion between facts and fiction, or as the political analyst Yaron Ezrahi described it, between high-cost and low-cost realities (*3*). Ezrahi distinguishes between constructs of the world that require heavy investment of resources, such as time, money, efforts, and skills, and those which engage fewer resources on the part of those who consume these realities. Scientific knowledge constructs high-cost reality, usually based on a densely organized system of concepts, facts, rules, interpretation, methodological skills, equipment, and evidence. As such, the knowledge is not directly accessible to laypersons and remains esoteric. Low-cost realities may be expensive to produce, but are "cheap" to consume. They depend on the immediate experience of the flow of images and sounds. They become the shared means by which the public conceives, imagines, remembers, thinks, and relates or acts in politics. They allow the public to simulate the witnessing of real events without the trouble of being actually there. Low-cost reality is a spectacularly successful commercial product in our culture.

Richard Feynman once used the analogy (*4*) of a Mayan priest who had mastered the numerical concept of subtraction and other elaborate mathematical rules. He used them to predict the rising and setting of Venus. However, to explain his approach to an audience who did not know what subtraction is, the priest resorted to counting beans. The important thing, said Feynman, is that it makes no difference as far as the result is concerned: We can predict the rise of Venus by counting beans (slow, but easy to understand) or by using the tricky rules (which are much faster, but it takes years of training to learn them). However, we have not taken the public through the tedium of bean counting, nor—apart from some notable exemptions—focused on teaching the tricks. Instead, we have been proud to re-enact on the public stage the spectacle of the Maya priest stepping forward before the attentive crowd and announcing the rise of Venus—while Venus rises indeed under the applause and to the relief of the viewers. We have learned how to stage such events ourselves and have come to believe that we thereby render a public service. We have largely engaged in the construction of low-cost realities that appeal to emotions and the imagination. There have certainly been charges that selling science as sexy has gone too far (*5*), amusing as it may be to explain the magic in Harry Potter in scientific terms (*6*). Some have said that by turning the Year of Physics de facto into the Year of Einstein, the point is missed that physics, while central to our understanding of the Universe, is also central to making useful and practical things through engineering (*7*). Although it is exhilarating to think of science's role in extending the frontiers of our knowledge, it is critical that the public remembers how important science is to their day-to-day reality. There are critical issues that need to be discussed, although they are not especially glamorous, such as the ongoing shift between the public nature of sci-

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ence and the tendency toward its propertization (*8*) or the upcoming debate about security-oriented research and the potential clash between the public interest in scientific openness and its security interests. Sexy communication is not going to be enough to inform good decision-making.

Declining trust in science and scientific experts has been clear in public controversies like genetically modified organisms (GMOs) or the bovine spongiform encephalopathy (BSE) crisis, as well as in the rejection of scientific evidence regarding vaccination safety in the UK. The Euro-barometer, conducted as an EU-wide survey, probes the state of mind of EU citizens and how they view science and technology. The most recent data are expected to be published in mid-May and, for the first time, will be commented on by a panel of experts. The 2001 survey (*9*) revealed that two-thirds of the public do not feel well-informed about science and technology, and the number of people who believe in the capacity of science and technology to solve societal problems is declining. Trust in science in general seems to be on the decline in many national surveys, although scientists still come out way ahead of politicians or other public institutions.

There are currently clear examples of research on the frontiers of science clashing with human beliefs and values. From the United States, voices can be heard deploring the tendency of politicians to interfere with scientific agendas in teaching and in research (*10*) and faith-based opposition to the teaching of evolution and some forms of frontier research, like stem cells continue to raise serious concern. Luckily, creationism/evolution is not an issue in Europe, largely due to the centralized education systems in most countries. However, an analogous situation exists for stem cell research, with some countries, like Germany and Italy, completely opposed. There will be a referendum in Italy shortly on stem cell research. The Catholic church urges the public not to vote, in the hope that the necessary 50% quota will not be reached, and the referendum will be defeated.

Although we may welcome greater public interest in science, if only to avoid another backlash in fields like nanotechnology as occurred with GMOs, we must also confront the thorny issue of how contemporary democracies will deal with minorities who, on faith-based or other, value-related grounds, refuse any compromise. There is no reason to believe that Europe will be immune to an ascendancy of groups who oppose otherwise promising lines of research on the basis of their value system. If the values dimension is here to stay, it is far from certain that the usual response of setting up ethical guidelines and committees will suffice, let alone that any of the efforts to "better communicate science" will have any effect.

If the goal is a more research-friendly society, one in which research and innovation become embedded in society and an expression of "the capacity to aspire" (*11*), we have to explain what research is and how the process of research is actually carried out. We need to focus more on the processes of research; on the inherent uncertainty that is part and parcel of it; on how bottom-up and top-down approaches intersect; on the actual, and not only idealized, role that users play; and on how research funding agencies work, both on national and supranational levels. We should explain how research priorities are set, because it is not nature whispering into the ears of researchers, but an intricate mixture of opportunities and incentives, of prior investments and of strategic planning mixed with subversive contingencies. We would also be better poised to explain to the wider public the difference between claims or promises made on the part of researchers, depending on whether these claims have been peer-reviewed or not. How should the public know about these rules that play such an important part for the scientific community, see their significance as well as their limitations, unless we explain how they actually work? Or how should they know about the differences in scientific cultures, what counts as evidence, or how consensus is reached with criticism being an essential precondition for moving toward it, if nobody tells them?

To observe and explain what scientists are really doing requires that we make the multiple links of interaction between science and society transparent, as well as the institutions that mediate and shape science policies. The dialogue needs to be extended into the world of politics, economics, and culture, including how scientists are influenced by globalization. There is a need for additional capacity building so that civil society can become a partner in this encounter with science. Apart from patient groups or organizations that have sponsored research into orphan diseases, there has been little organized effort in Europe so far.

It is only fair to say that much has been accomplished. The initial notion of public understanding of science as a didactically conceived one-way street through which scientific literacy is diffused did not miraculously lead to increased public support for science. It is increasingly being replaced by concepts of public awareness of science and public engagement with science. Activities that have been undertaken in this more interactive and outreaching mode range from the "Physics for taxi drivers" in London (*12*) to the regular public science festivals occupying their place alongside other, cultural, festivals. The 16th International Science Festival which has recently occurred in Edinburgh (*13*), and the Swiss "Science et Cité" initiatives stand out (*14*) as good examples of forums that encourage discussion and debate. Almost all member states of the European Union now celebrate European Science Week (*15*). The European Science Open Forum (ESOF) was a highly successful European event in Stockholm in 2004 and will be held again in Munich in 2006.

The larger (and richer) research institutions, such as the Max Planck Society in Germany or the CNRS in France, have set up their own outreach and public relations units. The current Framework Programme of the EU foresees outreach activities as an integral part of the contract obligations, although it is regrettable that outreach is not considered a factor in evaluating research proposals. The European Commission's proposed 7th Framework Programme, published on 6 April 2005, foresees an expanded "Science in Society" action line with an increased provisional budget of €554 million (US$712 million) for 7 years.

Successful communication can begin to be measured through short-term indicators, such as improvements in public opinion polls on trust in science or increases in enrollment figures for undergraduate physics or chemistry programs. In the longer term, we will need to measure evolution in the direction of scientific citizenship, which presupposes rights and duties on the part of citizens as much as on the part of political and scientific institutions. Innovation is the collective bet on a common fragile future, and neither science nor society knows the secret of how to cope with its inherent uncertainties. It can only be accomplished through an alliance among the participants and a shared sense of direction.

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